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METHOD OF INHIBITING CORROSION IN STEAM GENERATING SYSTEMS

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This invention relates to a highly effective method of retarding corrosion of ferrous metals in steam generating systems, particularly in condensate lines thereof.

The usual steam generating systems comprise a boiler in which water is heated to temperatures ordinarily in the range from 250° F. to 500° F. to generate steam, a steam line to carry the steam from the boiler to the point of use, the heat exchangers, turbines, etc., where the steam is condensed, and a condensate line to return condensed spent steam to the boiler drum. Steam generating systems are ordinarily constructed of iron or steel, which corrodes in normal usage, with the result that maintenance costs are increased and equipment life is shortened. Particularly susceptible to corrosion are the sections of the steam plant wherein the steam is condensed, i.e., in the zone of condensation. One particular form of steam generating plant is the steam system used in stripping gasoline fractions from rich oil separated in a natural gasoline plant. In such systems the condensed steam contains corrosive amounts of carbon dioxide and sometimes oxygen.

In accordance with the present invention, effective inhibition of corrosion of the steam and condensate lines of steam generating systems can be obtained when nitroalkanes of no more than four carbon atoms are introduced into the feed water in small amounts, usually in the range of 0.001 to 0.2 percent by weight of the total water (liquid and vapor) in the steam generating system. Stated in terms of steam rate, the niroalkane is introduced at a rate of ¼ to 2 quarts per day per 10,000 pounds per hour of steam. Further, it has been found that the nitroalkanes are most effective when the content of salt (namely, alkali metal chloride) in the condensed water is below about 500 p.p.m., preferably below 100 p.p.m., calculated on the basis of all salts being present as sodium chloride. In a test with the salt content above 500 p.p.m., the addition of a nitroalkane, such as 2-nitropropane, to the boiler water was found to increase surprisingly the corrosivity rather than decrease it. Therefore, the introduction of nitroalkane into the water to inhibit corrosion of ferrous metal in the condensing zone of a steam system is advantageously accompanied by maintenance of the concentration of alkali metal chlorides in the condensed water below the above-mentioned concentration. By carrying out the treatment in such manner, corrosion of the ferrous metal parts of the steam system is greatly inhibited.

Illustrative of the nitroalkanes of no more than four carbon atoms that may be employed in accordance with the present invention, are the following: nitromethane, nitroethane, 1-nitropropane, 2-nitropropane, 1-nitrobutane, and 2-nitrobutane. These compounds are liquids and may be used as such or dissolved in an inert carrier, such as water or a hydrocarbon solvent, e.g., kerosene, methanol, and the like.

Data indicating the unusual effectiveness of the method of the present invention in inhibiting corrosion in steam generating plants are summarized in the following Table 1. The nitroalkanes were introduced continuously at the indicated rates into a steam generating plant running at a steam rate of 33,000 pounds per hour at a temperature of 300° F. and at a pressure varying throughout the system from 60 to 600 p.s.i.g. The chloride content

of the boiler water was maintained below 20 p.p.m., calculated as sodium chloride. Iron coupons were suspended in the condensate line wherein the corrosion is most difficult to inhibit. Corrosion rates are expressed in mils per year and were calculated from the weight loss of the coupons during the tests. A suitable corrosion measuring device is described at page 85 of the January 21, 1957, issue of the Oil and Gas Journal.

TABLE 1

Test Series Number	Inhibitor	Injection Rate (Qts./day)	Time After Start of Test Series (hrs.)	Corrosion Rate (mils./yr.)
1	2-nitropropane.	2.5	0–9	143.
		2.5	15–94	2.8.
		1.8	8–85	5.3.
2	do	2.5	85–95	
		2.5	95–150	2.7.
		3.1	100–170	1.4.
3	do	3.6	290–420	0.7.
		4.3	430–600	0.3.
		5.4	770–820	0.0.
		1.8	60–120	2.8.
		4.3	170–230	0.
4	Nitromethane.	None (from 230 hours)	260–285	106.
		2.8	285–290	Rapidly decreasing.
		2.8	290–305	0.
		2.4	305–395	0.

Inspections of the steam generating plant showed that corrosion was also being inhibited in the less sensitive portions thereof.

The relationship of injection rate of nitroalkanes to the corrosion rate are shown in Table 3, the measurements being made as described above, except that the injection rates have been converted to the basis of 10,000 pounds per hour of steam.

TABLE 2

Inhibitor	Inhibitor Injection Rate (Qts. per day)	Corrosion Rate (Mils./year)
Nitromethane	0.6	1
Do	0.8	0
1-nitropropane	0.6	5
Do	0.63	4
Do	0.81	2.8
Do	1.2	0.7
Do	1.4	0.3

The above data clearly illustrate the marked effectiveness of the nitroalkanes in reducing corrosion in steam generating plants and that the lower molecular weight nitroalkane, namely nitromethane, was more effective on an equal unit volume rate basis.

The data in following Table 3 illustrate that the effectiveness of the nitroalkanes is diminished as the chloride content of the total water in the steam generating system is increased to 100 p.p.m. and to 500 p.p.m., calculated on a sodium chloride basis:

TABLE 3

Inhibition of Steam Condensate Corrosion at 160° F. and pH 5.4

Test Series Number	Inhibitor	Injection Rate (p.p.m.)	Sodium Chloride Concentration (p.p.m.)	Corrosion Inhibition (percent)
5	Nitromethane.	50	1	99
6	do	50	50	80
7	do	50	100	60
8	do	50	500	20
9	do	50	600	−10

I claim:

1. The method of inhibiting corrosion due to steam condensing in the presence of carbon dioxide and oxygen in the condensing zone of a steam generating system where water is cycled through a boiler converting liquid water to steam, the condensing zone with steam condensing and normally causing corrosion at the elevated temperature and a condensate line returning condensed spent steam to the boiler, which method comprises maintaining a concentration of alkali metal chlorides in the total water, liquid and vapor, in said system below 500 p.p.m., calculated on the basis of all chlorides being present as sodium chloride, and introducing into the water in said system a quantity of mononitroalkane having no more than four carbon atoms, said quantity being sufficient to give the water a concentration of said nitroalkane in the range of 0.001 to about 0.2 percent by weight.

2. The method of inhibiting corrosion due to steam condensing in the presence of carbon dioxide and oxygen in the condensing zone of a steam generating system where water is cycled through a boiler converting liquid water to steam, the condensing zone with steam condensing and normally causing corrosion at the elevated temperature and a condensate line returning condensed spent steam to the boiler, which method comprises maintaining the concentration of alkali metal chlorides in the total water, liquid and vapor, in said system below 100 p.p.m., calculated on the basis of all chlorides being present as sodium chloride, and introducing into the water in said system a mononitroalkane having no more than four carbon atoms at a rate in the range of ¼ to 2 quarts per day of said nitroalkane per 10,000 pounds of steam per hour.

3. The method of claim 2 wherein said nitroalkane is 2-nitropropane.

4. The method of claim 2 wherein said nitroalkane is nitromethane.

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